

AVAILABILITY OF LANDSAT DATA PRODUCTS

Reference Material Prepared for:

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INTRODUCTION

Data from Earth Resources Landsat Satellites have been received at the EROS Data Center (EDC) since mid-summer of 1972. Consequently, a large amount of data, acquired mostly over the land masses of the Earth, are available and in the public domain. The following overview is a description of the general state of data availability at this time.

Of primary importance to the Landsat Program are the satellites themselves. To date, three Landsat satellites have been placed in orbit with plans for a fourth one currently proceeding on schedule. Although the design life of a Landsat satellite is one year, actual performance has far exceeded this expectation. The result has been a large volume of data becoming available.

The first two satellites carried a three-band return beam vidicon (RBV) system and a four-band multispectral scanner (MSS) system as the primary sensors. These sensors acquired data over areas roughly 115 x 115 miles on a side, from which photographic products at scales ranging from 1:3,369,000 to 1:250,000 were made available. Landsat 3 carries a twin panchromatic RBV system with alternate optics (2X focal length) resulting in one-fourth the ground coverage at one-half the scale for the same size MSS photo products. Landsat 3 also carries a five-band MSS which includes a thermal band. Landsat 3 MSS data is available in the same sizes and scales as previous MSS data. Figure 1 summarizes the status of all three satellites.

Plans for Landsat D (the letter D will change to a 4 after launch) call for a four-band MSS and a seven-band thematic mapper.

Data acquired by the Landsat satellites is transmitted to receiving stations operated not only by the U. S. but by a number of foreign countries as well. The foreign ground stations include two in Canada, one each in Sweden, Japan, Brazil, Italy, Iran, and additional stations planned in

LANDSAT SYSTEMS STATUS

	LANDSAT 1	LANDSAT 2	LANDSAT 3
DATES OF OPERATION	7/23/72 - 1/6/78	1/22/75 - PRESENT	3/5/78 - PRESENT
SENSOR PACKAGE	4 BAND MSS 3 BAND RBV	4 BAND MSS 3 BAND RBV	5 BAND MSS TWIN PANCHROMATIC RBV
TOTAL SCENES ACQUIRED	146,092 SCENES	145,242 SCENES	56,652 SCENES
SYSTEMS INOPERATIVE	RBV: 8/6/72 VTR1: 7/2/74 VTR2: 1/6/78	VTR1: 1/13/77	BAND 8: 3/23/79

Figure 1

Australia, India, and Argentina. The U. S. operates three Landsat tracking and ground receiving stations located at NASA facilities in Greenbelt, Maryland; Goldstone, California; and Fairbanks, Alaska. Figure 2 shows all ground station locations.

Outside the direct receiving ranges of the existing ground stations, Landsat data can be acquired and stored using on-board, wide-band video tape recorders and then subsequently transmitted to a ground receiving station when the satellite passes within range. Whether received by real-time transmission or by tape recorder playback, the data are preserved by the ground stations in the form of wide-band video tape recordings. Recordings from the U. S. ground stations, until recently, were shipped by air carrier to NASA's National Data Processing Facility at the Goddard Space Flight Center in Greenbelt, Maryland. Goddard produced 70-mm master film rolls of the imagery and provided copies to the EROS Data Center. EDC then filled customer orders for photographic reproductions. Also in response to orders, EDC requested Goddard to create and provide master computer compatible tapes (CCT's) for reproduction and dissemination at EDC.

With the system changes made recently, major improvements in receipt, production, and dissemination of Landsat data are now being realized.

In February major new digital image processing systems were placed in production at both NASA and EDC installations, removing the need for transfer of data via second generation film masters. These systems, first for MSS data, then later for RBV as well, allowed transfer

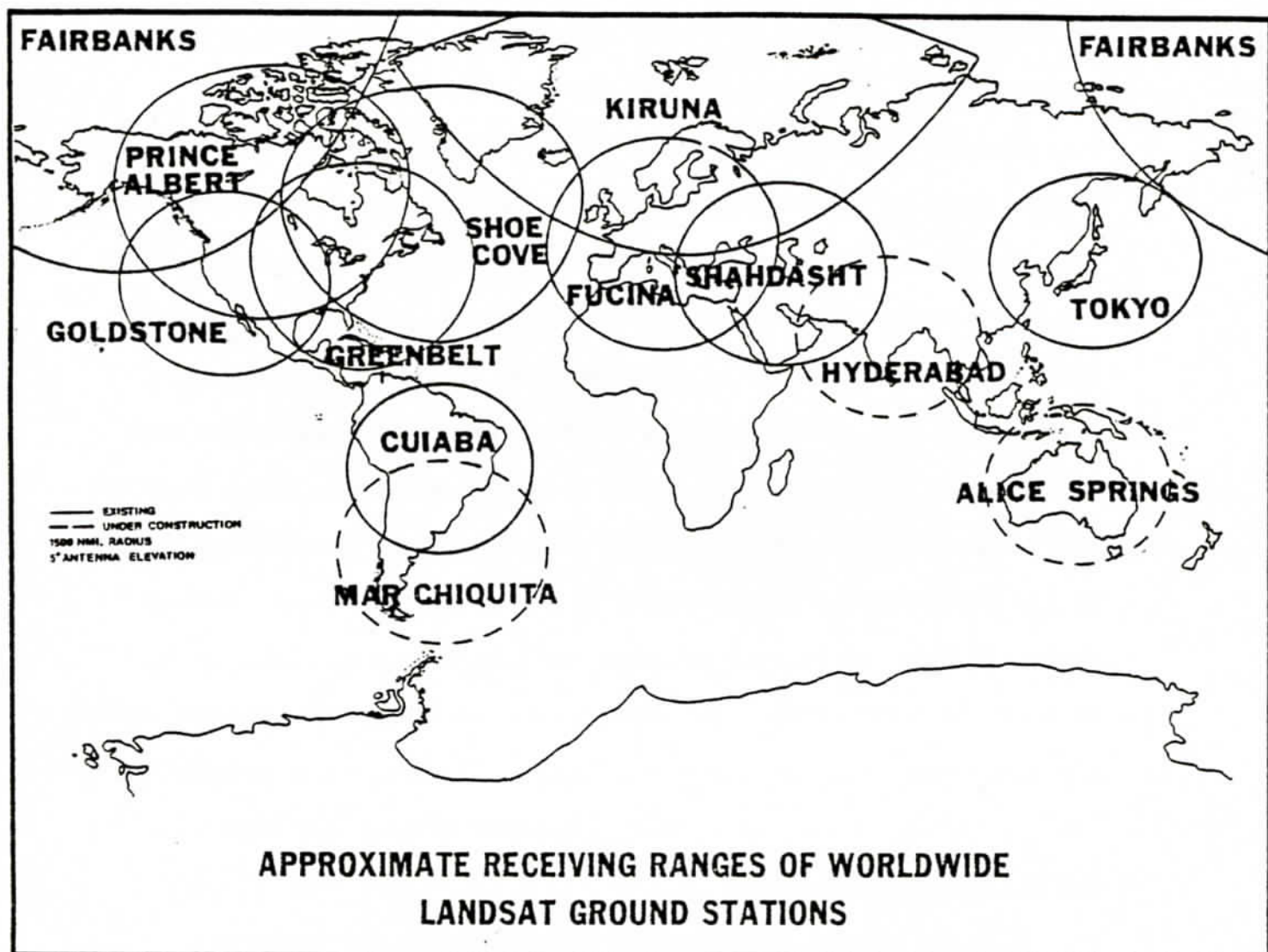


Figure 2

of images in a first generation, highly flexible digital format. In this format the data, having been geometrically and radiometrically corrected by the Master Data Processor (MDP) at Goddard Space Flight Center, are processed by the EROS Digital Image Processing System (EDIPS) to produce 9 1/2-inch film chip masters, and computer compatible tapes (CCT's).

During April and May, further improvements in data availability resulted from installation of domestic satellite (Domsat) transmission reception facilities at the ground receiving stations and the EROS Data Center. Since implementation, this capability has removed the delays in data availability imposed by shipment of the data via common carrier. Figure 3 summarizes the processing systems and data formats for all of the satellites to date.

EDIPS and the Domsat transmission capabilities represent a significant upgrade to the Landsat system and afford a substantial improvement in data processing timelines. Figure 4 depicts the original (pre-EDIPS) data flow. Figure 5 shows the data flow utilizing EDIPS and Domsat. Figure 6 shows the recommended technical system configuration for ground data handling of Landsat D (scheduled launch date: fourth quarter, 1981) thematic mapper (TM) data, including Domsat capability and the improved digital interface currently in use with Landsat 2 and 3.

Foreign Data Centers

NASA has entered into formal agreements with a number of foreign countries in which NASA agrees to provide direct transmission of Landsat data to ground stations located in the participating countries.

LANDSAT PROGRAM

Data Processing Systems Master Data Formats and Data Characteristics

NDPF: Dates of Operation July 23, 1972 to January 31, 1979				
FILM	MSS Bands 4-7 L/S 1,2,3	MSS Band 8* L/S 3	RBV Band 1,2,3 L/S 1,2	RBV Subscenes L/S 3
	70mm Second Generation Negatives in roll format provided to EDC by GSFC. Radiometrically and geometrically corrected.	241mm Second Generation negatives in roll format provided to EDC by GSFC. Radiometrically and geometrically corrected.	70mm Second Generation negatives in roll format provided to EDC by GSFC. Radiometrically and geometrically corrected.	70mm Second Generation negatives in roll format provided to EDC by GSFC. Radiometrically and geometrically corrected.
CCT's	Available through EDC from GSFC in pixel interleave format. Radiometrically corrected.	NOT AVAILABLE		

7

IPF/EDIPS: Dates of Operation February, 1979 to Present				
FILM	MSS Bands 4-7 L/S 2 and MSS Bands 4-8* L/S 3	RBV Bands 1,2,3 L/S 2		
	Data provided to EDC on High Density Digital tapes by GSFC. EDC produces 241mm first generation negatives in chip format, radio- metrically and geometrically corrected and radiometrically enhanced.	NO LONGER ACQUIRED		
CCT's	Available from EDC in line interleave or Band sequential format, radiometrically corrected. Customer may specify geometric correction and enhancement options.	Data provided to EDC on High Density Digital tapes by GSFC. EDC produces 241mm first gen- eration negatives in chip format radiometrically and geometrically corrected, radiometrically enhanced. Available from EDC in line in- terleave or subscene sequential format, radiometrically corrected. Customer may spec- ify geometric correction and en- hancement options.		

*Limited Band 8 acquired before sensor operation discontinued.
Band 8 may be acquired with Bands 4-7 on descending passes or
may be acquired alone on either descending or ascending passes.

Figure 3

1000170

LANDSAT 1 & 2 DATA FLOW PRE IPF/EDIPS

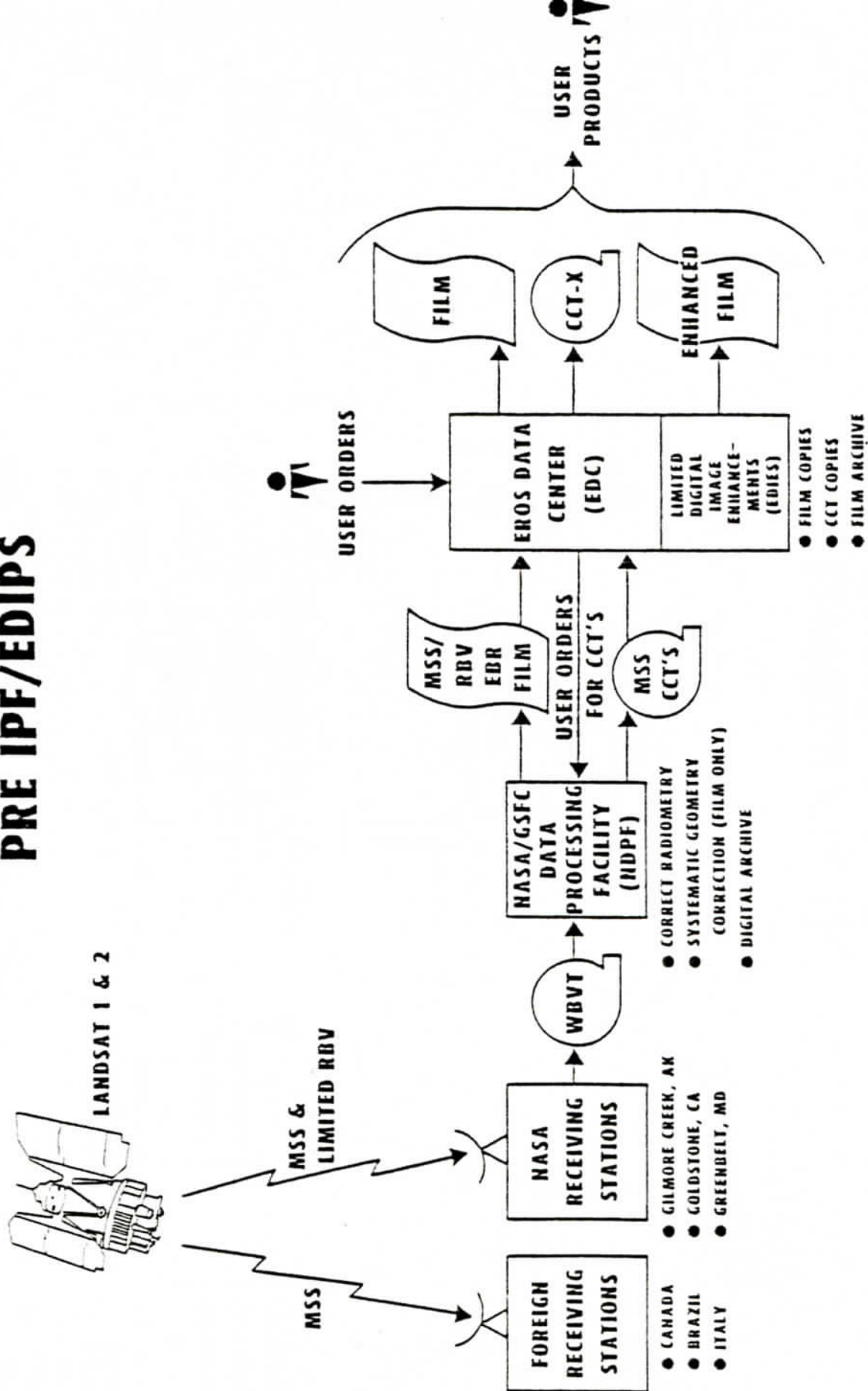


Figure 4

LANDSAT 2 & 3 DATA FLOW POST IPF/EDIPS (WITH DOMSAT)

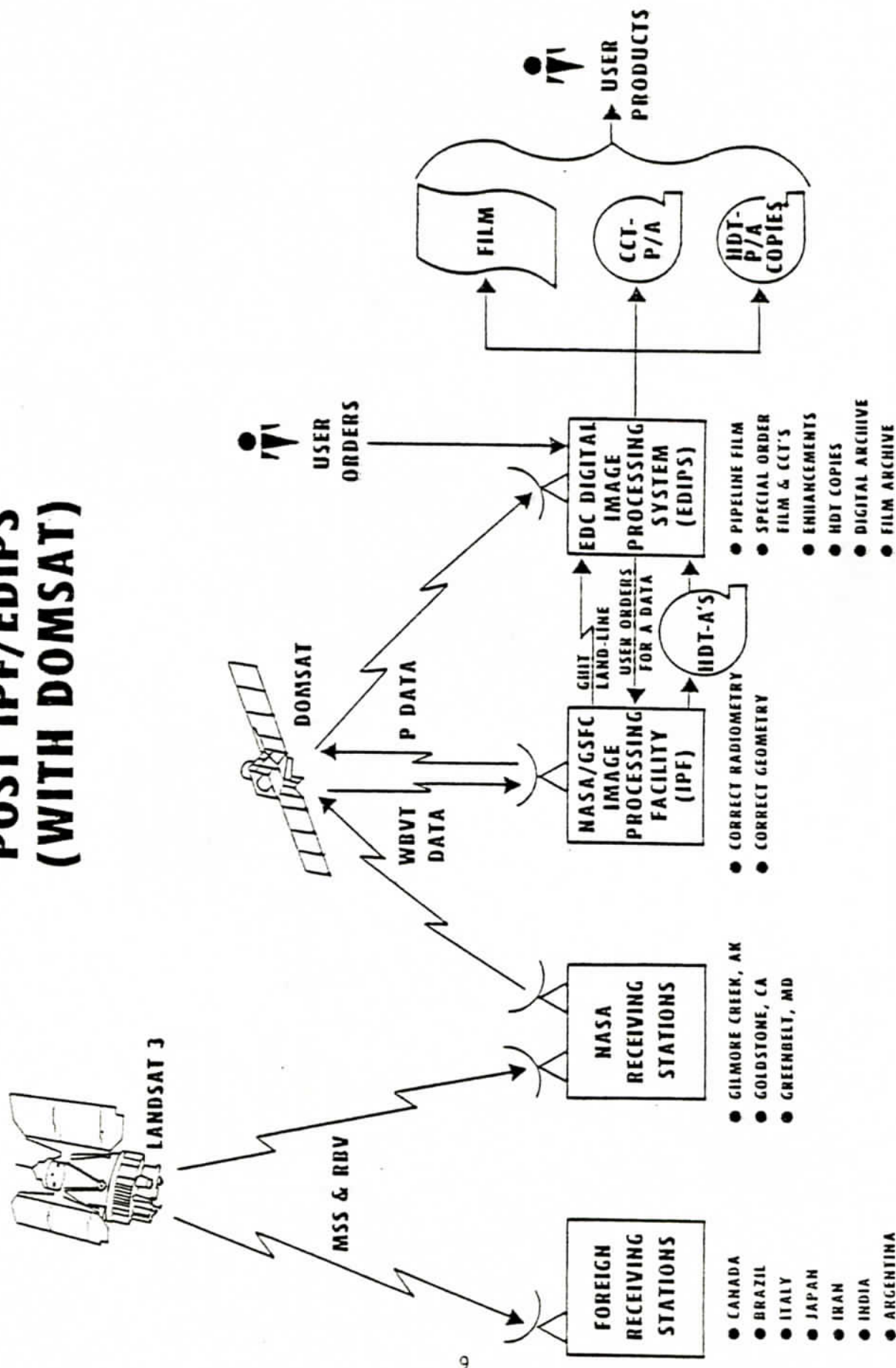
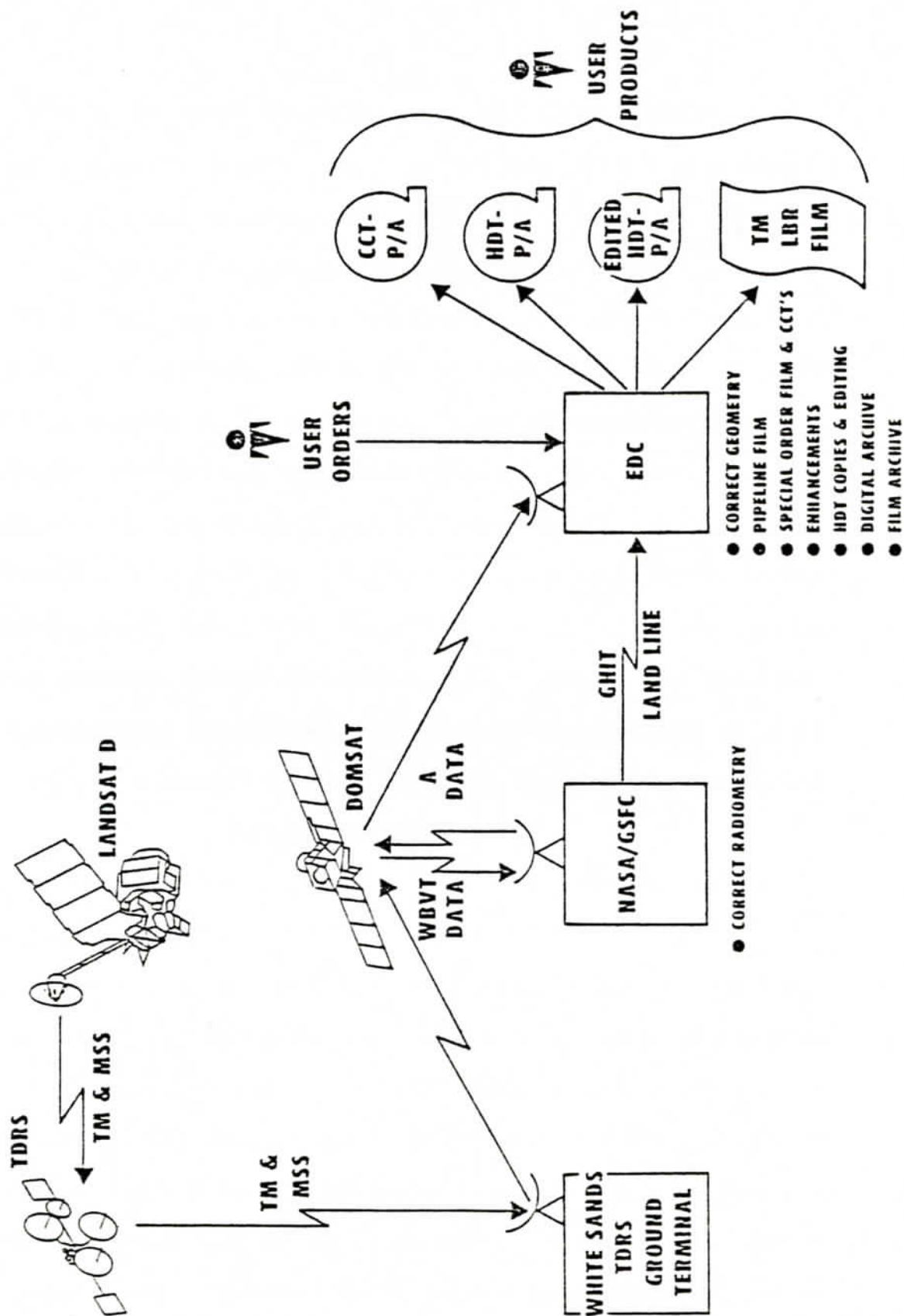


Figure 5

LANDSAT D TM DATA FLOW* (DIGITAL)



*MSS DATA FLOW IS THE SAME AS LANDSAT 3
EXCEPT EDC PROCESSES MSS-A DATA

Figure 6

Currently, ten foreign Landsat ground receiving stations in nine countries are operational or under construction. Foreign ground receiving stations have acquired a considerable amount of Landsat data (see Figure 7), and, because of technical problems with the satellite's on-board tape recorders, some data acquired outside the range of U. S. ground stations may be available only from the foreign receiving stations. In accordance with the NASA agreements, foreign stations are to provide data to interested users at a reasonable price. Inquiries about data holdings, price lists, and services offered can be addressed to the appropriate foreign Landsat data distribution centers listed in Figure 8. With some exceptions, Landsat products available from foreign ground stations are similar to those provided by U. S. data centers. As examples, summaries of available products from Canada, Brazil, and Italy are given in Figures 9, 10, and 11.

U. S. Data Distribution

Under management of the U. S. Department of the Interior, Geological Survey, the EROS Data Center was established to serve as the principal distribution facility for Landsat and other remotely sensed data. The data stored at EDC include over 1,250,000 frames of Landsat imagery; over 50,000 frames of Skylab, Apollo, and Gemini spacecraft data; more than 1,400,000 frames of data from the NASA research aircraft program; and over 3,200,000 frames of Department of Interior aerial mapping photography (Figure 12). Figures 13 and 14 list general characteristics of the photographic and digital products available from Landsat data.

LANDSAT DATA AVAILABILITY
FROM SELECTED FOREIGN RECEIVING STATIONS

(As of 5/30/79)

<u>Country</u>	<u>Data Holdings</u>
Canada	420,000 MSS and RBV Scenes
Brazil	75,000 MSS and RBV Scenes
Italy	92,000 MSS and RBV Scenes

Figure 7

ACTIVE FOREIGN LANDSAT DATA DISTRIBUTION CENTERS

June 4, 1979

<u>Country</u>	<u>Address</u>
Australia	Australian Landsat Station P. O. Box 13 Woden A.C.T. 2606 Australia
Brazil	INPE Caixa Postal 01 12630 Cachoeira Paulista, SP Brazil
Canada	CCRS 2464 Sheffield Road Ottawa, Ontario Canada
India	National Remote Sensing Agency Plot No. 4 Sardar Patel Road P. O. No. 1519 Secunderabad 500003 (A.P.) India
Iran	Iranian Remote Sensing Center National Iranian Radio and Television 80 Sepand St. Villa Avenue Tehran, Iran
Italy and Sweden	Earthnet - ESRIN via Galileo Galilei Casella Postale 04 00044 Frascati Italy
Japan	RESTEC Remote Sensing Technology Uni-Roppongi Bldg. 7-15-17 Roppongi Minato-ky Tokyo 106, Japan

Figure 8

AVAILABLE LANDSAT PRODUCTS
 ISIS LTD., PRINCE ALBERT,
 SASKATCHEWAN, CANADA

IMAGERY

<u>Image Size</u>	<u>Scale</u>	<u>Format</u>	<u>B&W</u>	<u>Color</u>
70mm	1:3,369,000	Film Pos., Neg.	X	
185mm	1:1,000,000	Film Pos.	X	X
185mm	1:1,000,000	Film Neg.	X	
185mm	1:1,000,000	Paper	X	X
371mm	1:500,000	Film Pos.	X	
371mm	1:500,000	Paper	X	X
742mm	1:250,000	Paper	X	X

QUICK LOOK IMAGE

- Isisfiche
- Facsimile

CCT'S

9 Track 1,600 bpi

Figure 9

AVAILABLE LANDSAT PRODUCTS
INPE, SAO JOSE dos CAMPOS, BRAZIL

IMAGERY

<u>Image Size</u>	<u>Scale</u>	<u>Format</u>	<u>B&W</u>	<u>Color</u>
59x73mm	1:3,704,000	Film Pos., Neg.	X	
220x270mm	1:1,000,000	Film Pos.	X	X
220x270mm	1:1,000,000	Paper	X	X
440x540mm	1:500,000	Paper	X	X
880x1080mm	1:250,000	Paper	X	

CCT'S

9 Track 800 bpi

Figure 10

AVAILABLE LANDSAT PRODUCTS
EARTHNET-ESRIN, FRASCATI, ITALY

IMAGERY

<u>Image Size</u>	<u>Scale</u>	<u>Format</u>	<u>B&W</u>	<u>Color</u>
55.8mm	1:3,369,000	Film Pos.	X	X
185mm	1:1,000,000	Film Pos., Neg.	X	X
185mm	1:1,000,000	Paper	X	X
371mm	1:5,000,000	Paper	X	X
742mm	1:250,000	Paper	X	

QUICK LOOK IMAGE

CCT'S

9 Track 800 bpi

Figure 11

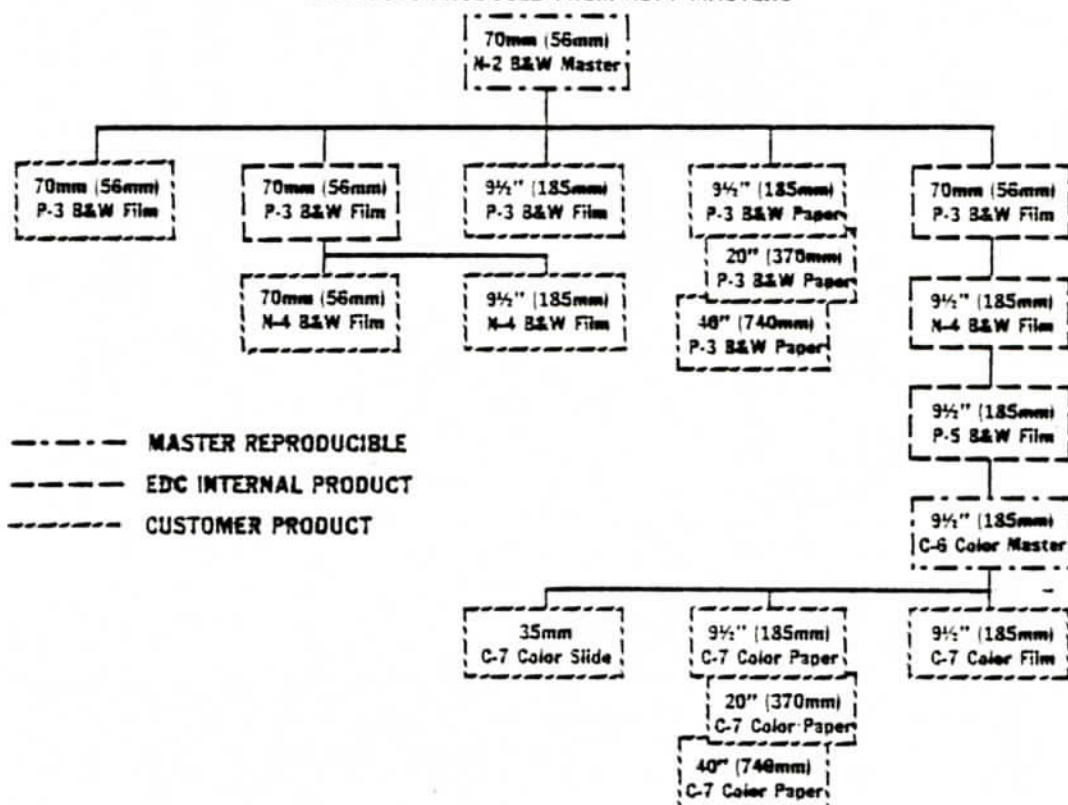
DATA HOLDINGS IN THE EDC
MAIN IMAGE FILE AS OF APRIL 30, 1979

	<u>Film Rolls</u>	<u>Frames</u>	<u>Georef Accession</u>
Apollo/Gemini Space Photography	122	12,134	478
Skylab Imagery	634	44,845	38,765
Landsat Data (MSS-RBV)	7,318	1,278,211	346,290(1)
			12,250(2)
			13,779(3)
TOTAL SPACE DATA	<u>8,074</u>	<u>1,335,190</u>	<u>411,562</u>
NASA Research Aircraft Imagery	10,187	1,411,095	139,959
USDI Aerial Mapping Photography	<u>22,026</u>	<u>3,275,437</u>	<u>70,366</u>
TOTAL AIRCRAFT	32,213	4,686,532	210,325
TOTAL EROS DATA CENTER HOLDINGS	<u>40,287</u>	<u>6,053,935</u>	<u>621,887</u>

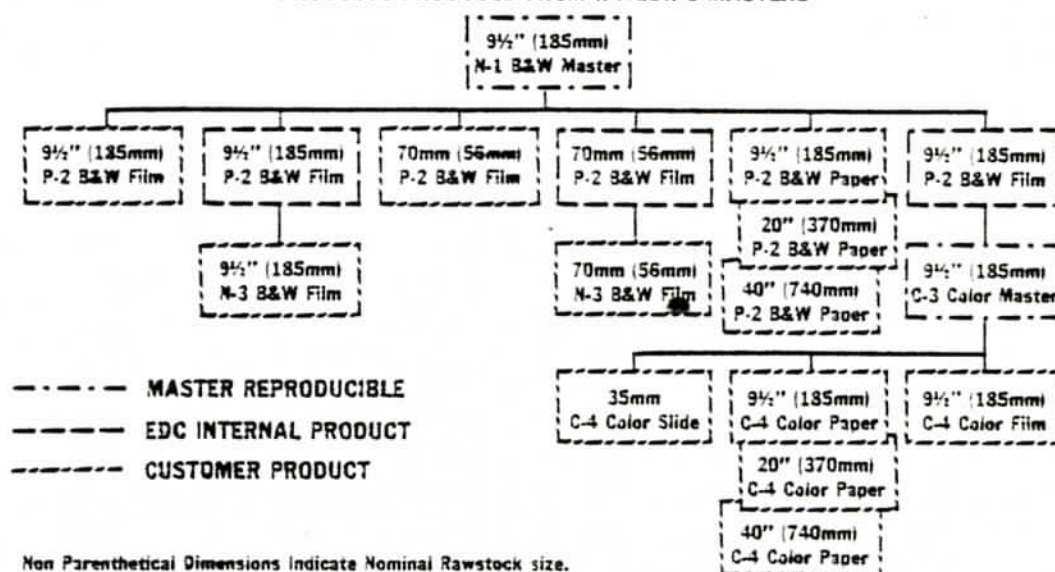
- (1) Black and White Scenes Retained at EDC
- (2) Color Composites Retained at EDC
- (3) Landsat Scenes Available from Brazil

Figure 12

**LANDSAT PROGRAM PHOTOGRAPHIC REPRODUCTIONS
AVAILABLE FROM USGS/EDC
PRODUCTS PRODUCED FROM NPPF MASTERS**



PRODUCTS PRODUCED FROM IPF/EDIPS MASTERS



Non Parenthetical Dimensions Indicate Nominal Rawstock size.

Dimension in Parentheses Indicate Nominal Image Size for MSS Data, RBV Varies Slightly.

Figure 13

LANDSAT PROGRAM

Digital Products Available From USGS/EDC

CCT's

CCT - "X" Format

BIP-2 Interleaving
Radiometrically Corrected
Quarter Swath Scan Lines
800 or 1600 BPI

CCT - IPF/EDIPS Format, Corrected

BIL or BSQ Formats
Radiometrically Corrected
Geometrically Corrected
Optional Radiometric Enhancements
Contrast Stretch
Haze Removal
Edge Enhancement
Optional Resampling
Nearest Neighbor
Cubic Convolution
Optional Map Projection
HOM/SOM
UTM/PS
Full Swath Scan Lines
800 or 1600 BPI

CCT - IPF/EDIPS FORMAT, Uncorrected

BIL or BSQ Formats
Radiometrically corrected only
Full Swath Scan Lines
800 or 1600 BPI

HDT's

HDTp - (Corrected)

Radiometrically Corrected
Geometrically Corrected
Optional Resampling
Nearest Neighbor
Cubic Convolution
Optional Map Projection
HOM/SOM
UTM/PS

HDTA - (Uncorrected)

Radiometrically Corrected Only
20,000 BPI

Figure 14

Specific information on data availability (e.g., areas of coverage, dates, quality, ordering procedures, etc.) may be obtained from the User Services Section at EDC or from one of the National Cartographic Information Center (NCIC) offices located across the country. NCIC provides integrated mapping, photographic, and geodetic control information and data, and has established a broad network of offices which in cooperation with the EROS Data Center provide data availability research and ordering assistance for Landsat data as well. In the future, NCIC affiliate offices will be located in all 50 states.

Depending on the user's requirements, a variety of resources are available to answer data availability questions. These include a computer accessible Main Image File data base in which are stored data descriptions of all EDC holdings, and a newly developed system of micrographic accession aids which are tailored to specific data types. The Landsat accession aids include microIMAGERY of Landsat data, allowing users to preview imagery prior to ordering, and microCATALOGS, consisting of listings of data base descriptions of all Landsat holdings at EDC and in the future will include the cooperating foreign stations.

The NCIC network offices vary in the resources available, however. Six of the offices offer full capability for computer inquiry, ordering, and accounting, in addition to maintaining complete micrographic accession aids libraries. Other NCIC offices have only a computer inquiry capability and/or an accession aid library for certain geographic areas (typically regional). Figure 15 indicates the location and classification of the various NCIC offices that are currently staffed.

EDC DATA AVAILABILITY SERVICES

NCIC NETWORK

TYPE OF OFFICE	LOCATION	LEVEL OF SERVICE
EDC	South Dakota	Full (Includes Ordering)
NCIC Branches	California	Full (Includes Ordering)
	Colorado	"
	Missouri	"
	Virginia (2)	"
	Mississippi	"
NCIC State Affiliates	Montana	Computer Inquiry, Accession Aids
	New Mexico	"
	Arizona	"
	Minnesota	"
	Texas	"
	South Carolina	"
	Nevada	Accession Aids
	Utah	"
	Louisiana	"
	Alabama	"
	Tennessee	"
	Georgia	"
	Virginia	"
	West Virginia	"
	Pennsylvania	"
NCIC Federal Affiliate	TVA	Computer Inquiry, Accession Aids

Figure 15

EDC DATA AVAILABILITY SERVICES

NCIC NETWORK

TYPE OF OFFICE	LOCATION	LEVEL OF SERVICE
EDC	South Dakota	Full (Includes Ordering)
NCIC Branches	California	Full (Includes Ordering)
	Colorado	"
	Missouri	"
	Virginia (2)	"
	Mississippi	"
NCIC State Affiliates	Montana	Computer Inquiry, Accession Aids
	New Mexico	"
	Arizona	"
	Minnesota	"
	Texas	"
	South Carolina	"
	Nevada	Accession Aids
	Utah	"
	Louisiana	"
	Alabama	"
	Tennessee	"
	Georgia	"
	Virginia	"
	West Virginia	"
	Pennsylvania	"
NCIC Federal Affiliate	TVA	Computer Inquiry, Accession Aids

Figure 15

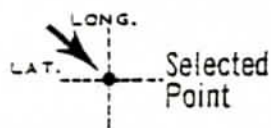
Computerized Geographic Search and Inquiry System

The computer system at EDC includes a data base of information that describes the characteristics of all data holdings.

Computer searches, through which this data base can be interrogated, can be accomplished by a visit, phone call, or letter to EDC. Such a search can isolate the individual images which satisfy user's specified requirements for geographic area, date of imagery, film type, scale, image quality, cloud cover, and so on. Some of the NCIC offices can also access this data base through their remote terminal hookups to the EDC system. A search may take various forms: a geographic point search can be conducted, for example, wherein all images whose coverage areas include a specified point will be retrieved, or a rectangular search may be done. With this method an area bounded by lines of latitude and longitude can be specified, resulting in retrieval of all images whose center points fall within that area. An irregular polygon having up to eight sides can also be used to specify an area of interest. Figure 16 illustrates these methods graphically. Geographic areas should be limited in size as much as possible to avoid retrieval of surplus image information.

Additional, secondary parameters supplementing the geographic specifications are normally used to refine and narrow further the output possible from a geographic search (Figure 17). These can include time of year, type of coverage, maximum cloud cover desired, and image quality specifications. Of course, some judgment is required. For example, if maximum acceptable cloud cover is specified as 10 percent or less over geographic areas that have frequent cloudy days, the

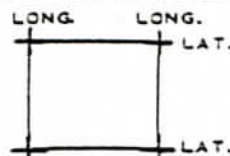
POINT SEARCH



Imagery with any coverage over the selected point will be included.

Latitude ° '
Longitude ° '

AREA RECTANGLE



Imagery with any coverage over the selected area will be included.

Longitude ° ' to Longitude ° '
Latitude ° ' to Latitude ° '

Figure 16 A geographic search may be requested using a point search or rectangular area search shown above. Additionally, an irregular polygon with up to eight sides may be used to define area of interest (not shown).

TYPE OF COVERAGE

- ☐ ERTS
- ☐ SKYLAB
- ☐ NASA-AIRCRAFT
- ☐ AERIAL MAPPING PHOTOGRAPHY

TIME OF YEAR

- ☐ JAN-MAR
- ☐ APR-JUNE
- ☐ JULY-SEPT
- ☐ OCT-DEC
- ☐ SPECIFIC DATES

TYPE OF PRODUCT

- ☐ BLACK & WHITE
- ☐ COLOR OR
COLOR INFRARED

MAXIMUM CLOUD COVER ACCEPTABLE

- ☐ 10%
- ☐ 30%
- ☐ 50%
- ☐ 80%
- ☐ 100%

MINIMUM QUALITY RATING ACCEPTABLE

- ☐ 0-2
(VERY POOR)
- ☐ 3-4
(POOR)
- ☐ 5-6
(FAIR)
- ☐ 7-9
(GOOD)

Figure 17 Geographic computer searches may be further defined by specifying type of coverage, time of year, type of product, maximum acceptable cloud cover and minimum acceptable quality.

listings of available scenes may be severely limited. Inversely, if cloud cover of 100 percent or less is specified for geographic areas that seldom have cloudy days, the computer printout may be voluminous and thus time consuming to evaluate. The intended application and individual requirements for data should be overriding factors.

An alternative method of specifying geographic area of interest is the Worldwide Reference System (WRS). The WRS is a global indexing system originally devised in Canada and since adopted by EDC. It enables the user to inquire about the availability of Landsat data over any geographic area in the world by specifying predetermined nominal scene centers based on the satellite orbit.

Nominal scene centers are defined by the intersections of path and row lines (Figure 18). Path lines are the ground tracks (orbital paths) of the satellites and are considered to be the vertical center lines of all scenes framed over any portion of a path. There are 251 path lines around the globe which are very nearly repeated every 18 days. The WRS path notation assigns a sequential number, from east to west, to each path, starting with number 1 for the first path that falls over mainland North America.

Row lines are parallel to lines of latitude and are considered the horizontal center lines of all Landsat scenes. They are related to the framing of individual images as the satellite progresses down one path. Exactly 119 scenes are possible in each descending path. Row lines are numbered from north to south, starting with row 1 at 80° N. latitude.

Actual centers of repetitive scenes may not be coincident with the nominal scene centers because of variations in satellite orbit, but they will tend to cluster around the path-row points that occur (Figure 19).

The path number is always given first, row second. And this is where the principal advantage of the WRS approach comes into play. In a manner similar to that of a rectangular search, the user can specify a geographic area bounded by path lines and row lines. A descriptive listing of available images will be obtained ordered by path, subindexed by row.

Regardless of the search method employed, data base information is provided in full. Ordering of image products becomes a matter of discerning which scenes possess the desired characteristics, and transcribing the appropriate information onto an order form. Figure 20 gives the categories of information that are provided for every scene on the computer listing.

Micrographic Accession Aids

Computerized geographic searches are not the only means of determining data availability, however. Users may obtain information through micrographic accession aids. These are microfiche systems which, incidentally, are based on the WRS. They have the built-in advantage of being self-indexing for this reason, and they do not require computer access or remote terminals in order to use them. They are known as the microCATALOG system and the microIMAGE system.

Each collection is ostensibly organized into zones. A zone is a range of rows, and Figure 21 depicts the three zones that exist:

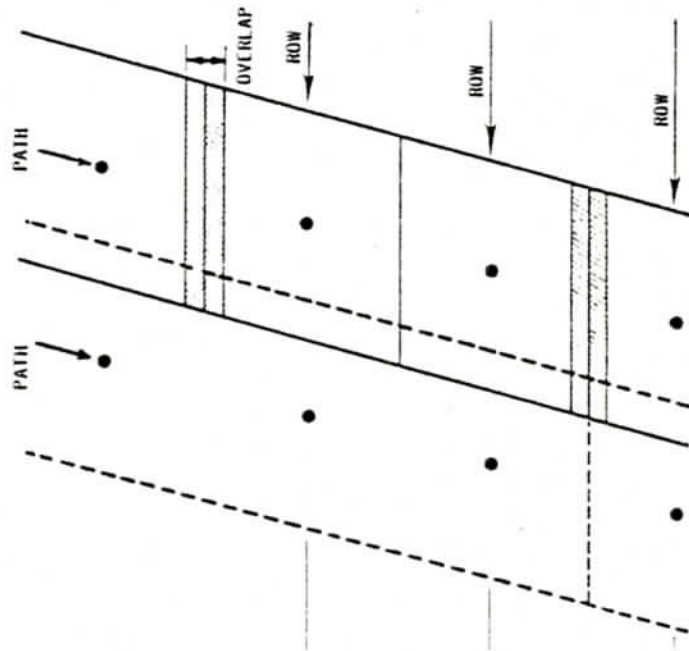


Figure 18-The nominal scene centers of the Worldwide Reference System (WRS) are formed by the intersection of path and row lines. A path line is the almost north-south Landsat ground track and row lines are lines connecting the latitudinal center of frames of imagery.

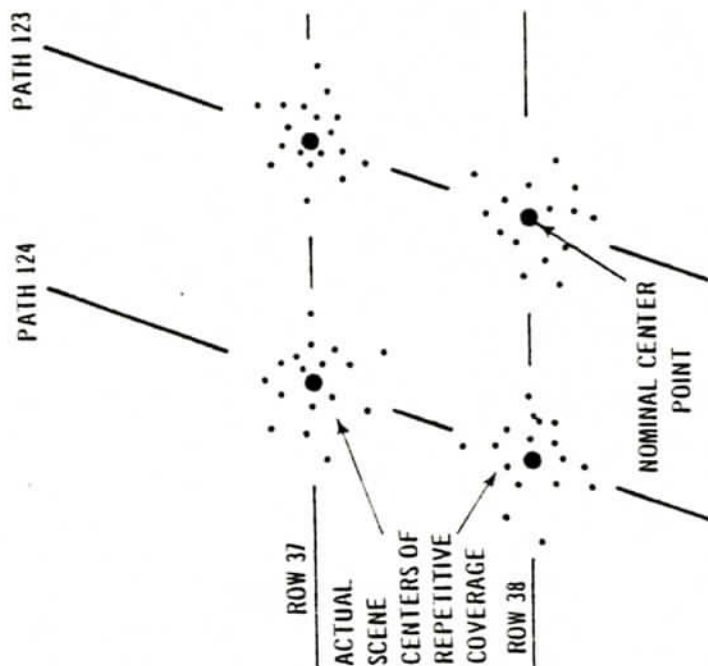


Figure 19-Variation in the satellite orbit and attitude cause the center points of repetitive scenes to cluster around the nominal center point.

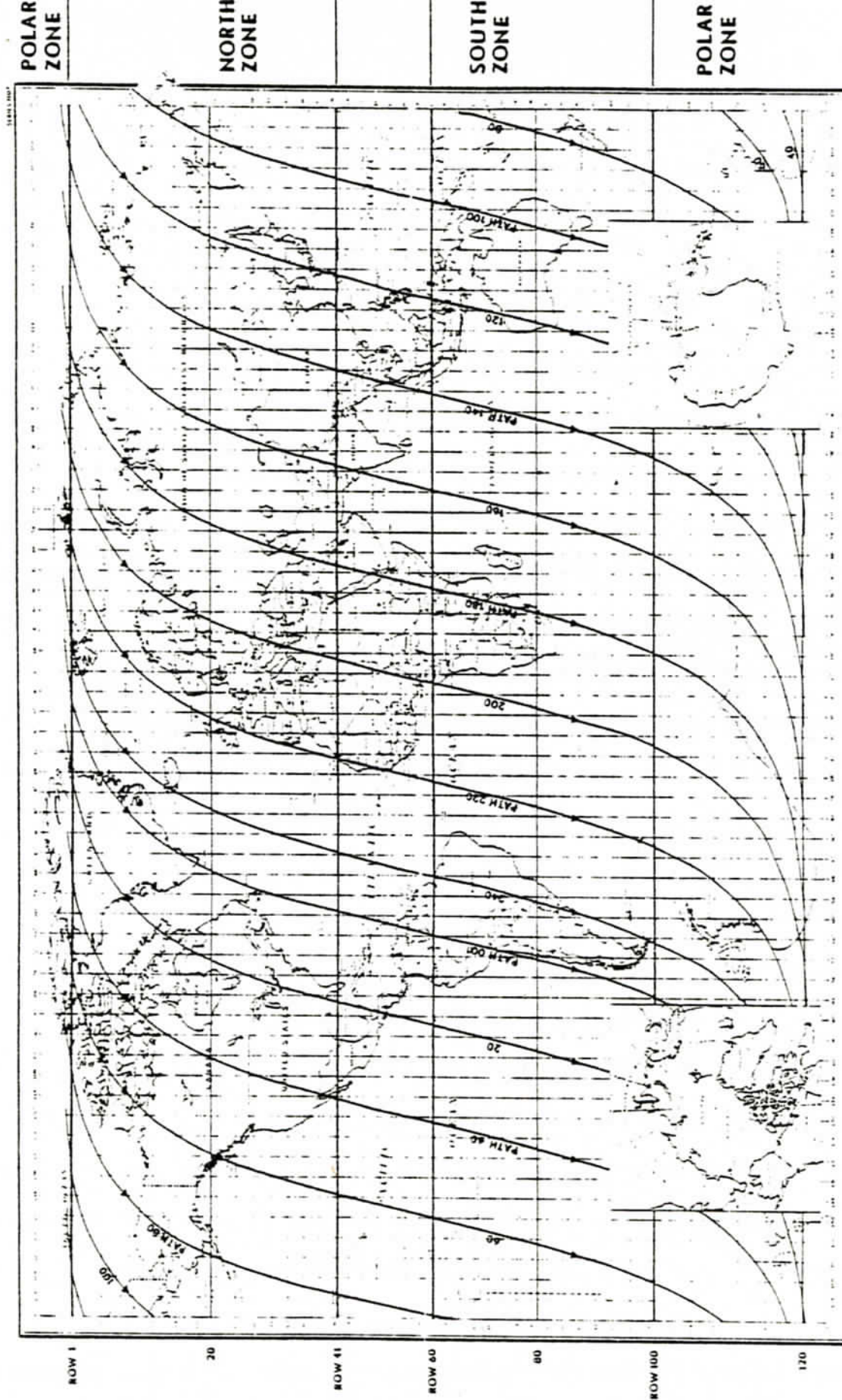
INFORMATION PROVIDED

ON

COMPUTER LISTING

- | | |
|----------------|--------------------|
| • IMAGERY TYPE | • CENTER POINT |
| • SCENE ID | • SCALE |
| • PATH, ROW | • ALTITUDE |
| • FILM SOURCE | • MICROFILM NUMBER |
| • QUALITY CODE | • CCT |
| • CLOUD COVER | • CORNER POINT |
| • DATE | |

Figure 20



LANDSAT MICROFICHE REFERENCE INDEX (DAY)

ZONE DEFINITIONS

Figure 21

the north zone, rows 1-60; the south zone, 41-100; and the polar zone, 101-119. Zone boundaries were chosen to minimize the need to acquire and/or research microfiche of more than one zone for a given area of interest. Zones can be further divided into groups of paths, known as regions. Regions have been identified to allow users to order microIMAGE or microCATALOG fiche which cover only their area of interest within a zone (Figure 22). This makes it possible to avoid purchasing an entire zone and, therefore, possibly more microfiche than are needed. Region or zone notwithstanding, the basic organization is reliant on the WRS scheme.

The Landsat microIMAGE collection comprises actual MSS images (usually band 5) for every scene acquired over a given path-row since February 1, 1979 (see Figure 23). The availability of the other bands and/or RBV subscenes that correspond to the MSS scene is also indicated for each scene (see Figure 24). This system permits a user to view a scene, a 48X reduction of same that is, prior to ordering. Position of cloud cover, actual ground coverage, and many other traits of the image of interest can be delved from the microIMAGE.

The Landsat microCATALOG collection consists of listings, again reduced facsimiles, of computer search results (see Figure 25). The searches are done within certain data ranges, so sometimes several fiche occur with one range. The advantage lies in being able to see the results of a search without having to wait for one to be mailed from EDC.

Ordering, Data Sales, and Trends

Once images that satisfy the user's requirements have been selected, orders for imagery or computer compatible tapes (CCT's) can be submitted.

LANDSAT MICROFICHE

REGION DEFINITIONS

Region I:	North Zone, Paths 58-97 Alaska and Hawaii
Region II:	North Zone, Paths 11-51 Continental United States and Central America
Region III:	North Zone, Paths 180-225 Europe and North Africa
Region IV:	North Zone, Paths 167-190 Middle East
Region V:	North Zone, Paths 140-170 India, Pakistan, and Burma
Region VI:	South Zone, Paths 229-251 and Paths 1-12 South America
Region VII:	South Zone, Paths 169-226 Central Africa and South Africa
Region VIII:	South Zone, Paths 94-141 Australia and Southeast Asia
Region IX:	North Zone, Paths 113-162 China and Japan
Region X:	North Zone, Paths 92-207 Asia

Figure 22

PATH	DAY OR NIGHT	DATE	(SATELLITE)						
ROWS	ZONE	MICROFICHE TYPE							
1 41 101	2 42 102	3 43 103	4 44 104	5 45 105	6 46 106	7 47 107	8 48 108	9 49 109	10 50 110
11 51 111	12 52 112	13 53 113	14 54 114	15 55 115	16 56 116	17 57 117	18 58 118	19 59 119	20 60 120
21 61 121	22 62 122	23 63	24 64	25 65	26 66	27 67	28 68	29 69	30 70
31 71	32 72	33 73	34 74	35 75	36 76	37 77	38 78	39 79	40 80
41 81	42 82	43 83	44 84	45 85	46 86	47 87	48 88	49 89	50 90
51 91	52 92	53 93	54 94 247	55 95 248	56 96	57 97	58 98	59 99	60 100

Figure 23. Arrangement of microframes on an individual fiche. The specific position of each Row number for the zones is shown. Each zone will appear on a separate fiche.

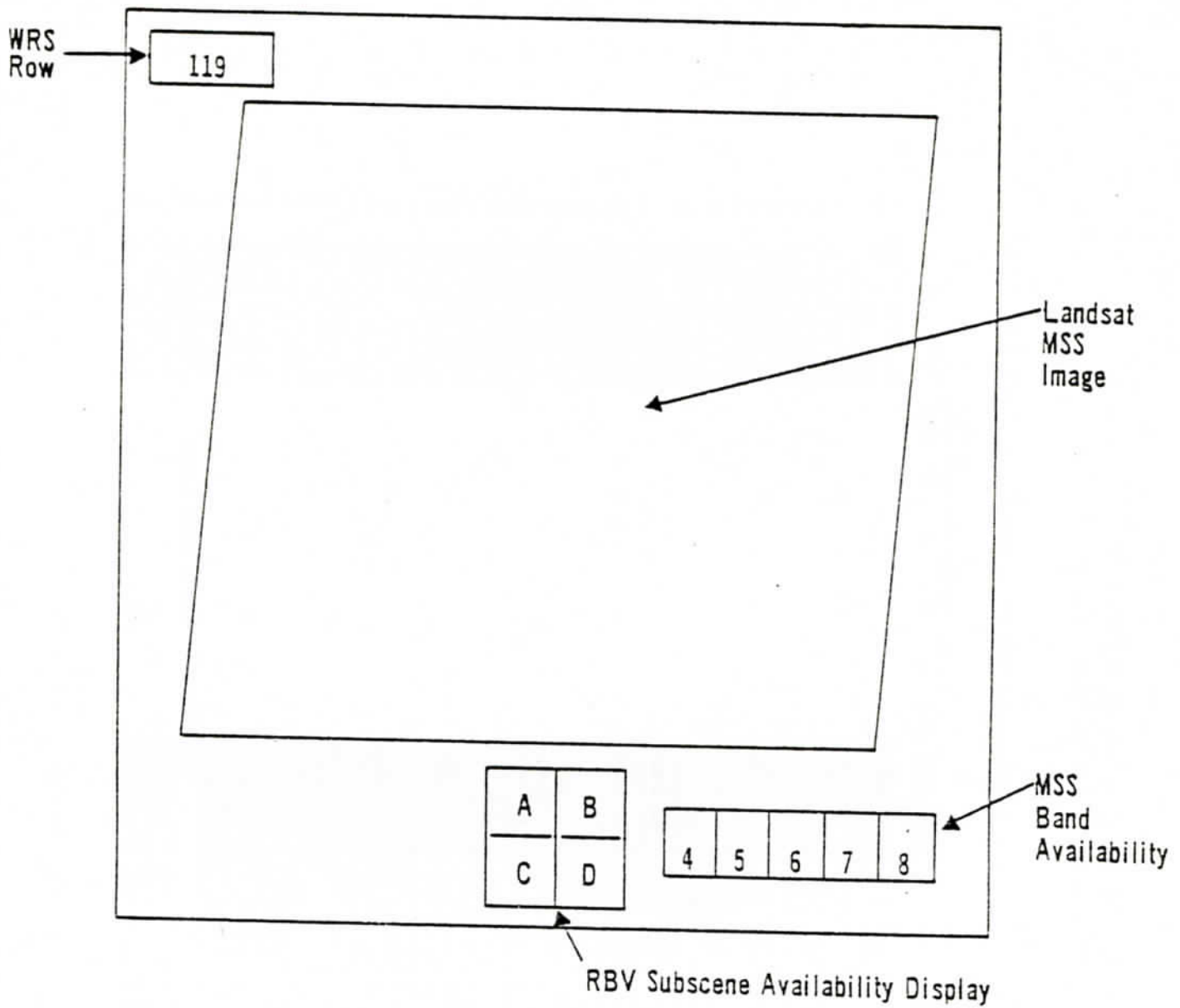


Figure 24. Format of an individual micro-frame on a microIMAGE fiche.

FORMAT OF AN INDIVIDUAL MICROFRAME
LISTING ON A MICROCATALOG FICHE

PATH 016(DAY)				ROM 033(NORTH)				LANDSNT 01/01/77 TO 06/15/78				GEOLOGICAL SURVEY, DEPT. OF THE INTERIOR					
DATE	S A	T	SEN	IMAGE CLD COV	L	C O	C T	C DIGIT QUAL	45678	CENTER COORDINATES	SEN	CLOUD COVER/IMAGE QUAL			DIG ABCD	SCENE ID	NS
												A	B	C			
01/15/77	2	155	0888	10x						B2100260482	11	*****	138057H005	1076055H005		8272414542500	N
02/02/77	2	155	0888	00x	7					B2100270757	Y	*****	138053H005	1076059H005		8274214534500	N
02/08/77	1	155	0885	00x						B1100560004	Y	*****	138051H005	1077005H005		8566114135500	N
02/20/77	2	155	0880	70x						B2100270903	11	*****	138049H005	1077002H005		8276014530500	N
02/26/77	1	155	0908	10x						B1100560057	11	*****	138051H005	1077004H005		8567914121500	N
03/10/77	2	155	0888	10x						B2100280700	11	*****	138046H005	1077004H005		8277814521500	N
03/28/77	2	155	0888	90x						B2100290548	11	*****	138049H005	1077001H005		8279614512500	N
05/03/77	2	155	0888	40x						B2100290236	Y	*****	138050H005	1076059H005		8281414502500	N
05/09/77	1	155	0888	50x						B1100580008	11	*****	138055H005	1077010H005		8283214493500	N
05/21/77	2	155	0888	10x						B2100310505	11	*****	138058H005	1076056H005		8575114054500	N
05/27/77	1	155	0888	10x						B1100590067	11	*****	138055H005	1077012H005		8285014483500	N
06/08/77	2	155	0888	10x						B2100310368	11	*****	138054H005	1076056H005		8576914040500	N
06/14/77	1	155	0888	90x						B1100590544	11	*****	138051H005	1077012H005		8286814473500	N
06/26/77	2	155	0888	10x						B2100320350	11	*****	138050H005	1076056H005		8578714022500	N
07/02/77	1	155	0888	10x						B1100600340	11	*****	138053H005	1077011H005		8288614464500	N
07/14/77	2	155	0858	10x						B2100321205	11	*****	138050H005	1076058H005		8580514003500	N
07/20/77	1	155	0888	70x						B1100610006	11	*****	138050H005	1077011H005		8290414455500	N
08/01/77	2	155	0858	70x						B2100330633	11	*****	138048H005	1076058H005		8582313584500	N
08/07/77	1	155	0858	40x						B1100610513	11	*****	138052H005	1077009H005		8292214445500	N
08/19/77	2	155	0888	40x						B2100340037	11	*****	138051H005	1076057H005		8584113564500	N
08/25/77	1	155	0885	10x						B1100620288	11	*****	138055H005	1077008H005		8294014435500	N
09/06/77	2	155	0888	40x						B2100340671	11	*****	138058H005	1076057H005		8585913545500	N
09/12/77	1	155	0860	00x						B1100620651	11	*****	138055H005	1077006H005		8295814425500	N
09/24/77	2	155	0858	50x						B2100341510	11	*****	138058H005	1076055H005		8587713525500	N
09/30/77	1	155	0828	20x						B1100630179	11	*****	138056H005	1077004H005		8297614415500	N
10/12/77	2	155	0888	50x						00000000000	11	*****	138054H005	1076055H005		8589513510500	N
10/18/77	1	155	0858	10x						B1100640024	11	*****	138054H005	1077005H005		8299414404500	N
10/30/77	2	155	0888	00x	7					00000000000	Y	*****	138052H005	1076058H005		8591313490500	N
11/17/77	2	155	0888	60x						00000000000	11	*****	138006H005	1076056H005		8601214394500	N
12/05/77	2	155	0855	90x						B2100370316	11	*****	138019H005	1077009H005		8603014390500	N
12/11/77	1	155	0808	20x						B1100650365	11	*****	138056H005	1076059H005		8604814381500	N
12/23/77	2	155	0888	70x						00000000000	11	*****	138042H005	1076059H005		8596713431500	N
12/23/77	1	155	0858	10x						00000000000	11	*****	138057H005	1077008H005		8606614375500	N
01/28/78	2	155	0888	10x						00000000000	11	*****	138046H005	1076049H005		8598513410500	N
02/15/78	2	155	0888	10x						00000000000	11	*****	138046H005	1076049H125		82110214381X0	N
04/10/78	2	155	0888	40x						00000000000	11	*****	138047H105	1076052H125		82112014391X0	N
04/13/78	3									00000000000	11	*****	138046H315	1076050H355		82117414422X0	N
04/28/78	2	155	0888	10x						00000000000	11	*****	138046H015	1076048H585		83004515072X0	N
05/07/78	3	155	0888	60x						00000000000	11	*****	138045H225	1076046H525		82119214432X0	N
05/25/78	3	155	0888	30x						00000000000	11	*****				83006315072X0	N
																83008115073X0	N

Figure 25

Individuals, government organizations, universities, and industry throughout the United States and any foreign country can, and have, done so. These orders may be placed at EDC or any of the NCIC branch offices and should be accompanied by check, money order, purchase order, or authorized account identification if a standing account has been established. (A current order form for commonly ordered "Standard" products is included as Figure 26.)

A detailed look at the principal users and purchasers of EDC products reveals that almost all categories of private industry in the United States and a wide variety of Federal, State, and local governmental agencies are currently using Landsat data for a variety of applications (Figure 27). The principal applications of the data appear to be mineral and fossil fuel exploration and related geologic mapping activities. These areas of application would appear to account for a significant portion of total sales of data from the EROS Data Center.

Total data sales for all categories of data since 1972 are shown in Figure 28. Landsat data has accounted for 65 percent of the gross revenue to date. Yearly figures for Landsat data only are shown in Figure 29.

The imagery and CCT data provided in FY 77 and FY 78 by EDC were distributed among the user community as shown in Figures 30 and 31. The majority of buyers of Landsat data are foreign countries, U. S. government, and U. S. industrial users.

Digital Image Processing of Landsat Data At EDC

The main purpose of processing Landsat data digitally is to provide high quality products that have increased information content

Form To:

**U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198
FTS: 784-7151
Comm: 605/594-8511
TWX: 910-668-0310**

NAME MR MS _____ (FIRST) (INITIAL) (LAST) _____ DATE _____

COMPANY _____ (IF BUSINESS ASSOCIATED) _____ COMPUTER ACCOUNT NO. _____ (IF KNOWN) _____

ADDRESS _____ PHONE (Bus.) _____

CITY _____ STATE _____ ZIP _____ PHONE (Home) _____

SHIP TO _____ YOUR REF. NO. _____ (P.O. GOVT ACCT. OR OTHER) _____

PLEASE TYPE OR PRINT PLAINLY

[illegible]

STANDARD PRODUCTS TABLE

BLACK AND WHITE PRODUCTS

NOMINAL IMAGE SIZE	PRODUCT		PRICE
	MATERIAL	CODE	
55.8mm (2.2 in.)	Film Positive	11	\$ 8.00
55.8mm (2.2 in.)	Film Negative	01	10.00
18.5cm (7.3 in.)	Paper	23	8.00
18.5cm (7.3 in.)	Film Positive	13	10.00
18.5cm (7.3 in.)	Film Negative	03	10.00
37.1cm (14.6 in.)	Paper	24	12.00
74.2cm (29.2 in.)	Paper	26	20.00

FALSE COLOR COMPOSITE PRODUCTS

NOMINAL IMAGE SIZE	PRODUCT		PRICE
		MATERIAL CODE	
18.5cm (7.3 in.)	Paper	63	\$12.00
18.5cm (7.3 in.)	Film Positive	53	15.00
37.1cm (14.6 in.)	Paper	64	25.00
74.2cm (29.2 in.)	Paper	66	50.00

PRICES SUBJECT
TO CHANGE

TOTAL ABOVE
TOTAL FROM
PREVIOUS SHEETS
TOTAL COST

A	
B	
C	

COLOR COMPOSITE GENERATION

NOMINAL IMAGE SIZE	PRODUCT		PRICE
	MATERIAL	CODE	
18.5cm (7.3 in.)	Printing Master	59	\$50.00

NOTE: Not applicable for RBV Subscenes. Printing Master is retained by EDC. Cost of products from this composite must be added to total costs.

COMPUTER COMPATIBLE TAPES (CCT)

TRACKS	BPI	FORMAT	MSS All Bands Available		RBV Single Subscene		Set of Four RBV Subscenes	
			PRODUCT CODE	PRICE	PRODUCT CODE	PRICE	PRODUCT CODE	PRICE
9	800	TAPE SET	183-B	\$200.00	193-C	\$200.00	183-D	\$400.00
9	1600	TAPE SET	184-B	200.00	184-C	200.00	184-D	400.00

PAYMENT MADE BY:

CHECK, MONEY ORDER ☐PURCHASE ORDER ☐

GOVT. ACCOUNT ☐

U.S. Geological Survey
National Cartographic
Information Center
National Space Technology
Laboratories
NSTL Station, MS 39529
FTS: 494-3541
Comm: 601/688-3544

PLEASE CONTACT THE
NEAREST NCIC OFFICE FOR
INFORMATION CONCERNING
THE AVAILABILITY OF
CARTOGRAPHIC PRODUCTS
OTHER THAN IMAGERY.

COMMENTS: _____

HOW TO ORDER STANDARD LANDSAT DATA

This order form is used to order all standard Landsat data. Necessary order information can normally be extracted from a computer listing of available data or from other Landsat references.

Please provide the following information in the indicated areas of the order form:

- A. List your complete NAME, ADDRESS, ZIP CODE, and name of your COMPANY if applicable.
- B. If you desire to have the products mailed to an address or individual other than yourself, please complete the "SHIP TO" address.
- C. List a PHONE NUMBER where you can be contacted during business hours.
- D. If you have had previous business with the EROS DATA CENTER, please list your COMPUTER ACCOUNT NUMBER if known.
- E. Please follow these instructions to determine which Columns apply when ordering photographic or tape products:
Use Columns marked SCENE IDENTIFICATION NUMBER, PRODUCT CODE, QUANTITY, UNIT PRICE, and TOTAL PRICE for all orders.
For MSS imagery also complete Columns MSS BANDS, AND NUMBER OF EACH.
- F. Enter the complete SCENE IDENTIFICATION NUMBER. This number can be transcribed directly from the COMPUTER LISTING or from a Landsat catalog.
- G. Review the STANDARD PRODUCTS table on the front of the ORDER FORM and determine the type of product desired.
- H. Enter the PRODUCT CODE of the type product being ordered from the STANDARD PRODUCTS table.
- I. If ordering MSS photographs, check columns for bands you desire and also indicate the copies of each band in the NUMBER OF EACH Column. It is not necessary to mark for RBV Subscenes since each has its own SCENE ID, but please complete the QUANTITY Column. Count the number of MSS bands checked, multiply by the figure in the NUMBER OF EACH Column and enter the RESULT in the QUANTITY Column.
- J. Enter the UNIT PRICE of the type product as reflected in the STANDARD PRODUCTS table.
- K. Multiply the figure in the QUANTITY Column by the UNIT PRICE and enter the result in the TOTAL PRICE Column.
- L. Repeat steps E through K for each product ordered.
- M. TOTAL the costs of all products ordered on this order form and enter the net result in BLOCK A (TOTAL ABOVE).
- N. For a single order form, enter the Figure in BLOCK A in BLOCK C (TOTAL COST). If more than one order form is required, on the last order form enter the sum of the figures in BLOCKS A in BLOCK B and then total BLOCK A and BLOCK B in BLOCK C (TOTAL COST).
- O. The COMMENTS portion is completed only when a CUSTOM PRODUCT is desired and you want to specify the parameters. Cost determination is normally based on three times the standard cost.
- P. PHOTOGRAPHIC and TAPE products are available in other formats but require special ordering procedures. If interested, please call the EROS Data Center for further instructions.
- Q. Include type of payment (purchase order, check or money order). Make all drafts payable to U.S. GEOLOGICAL SURVEY. DO NOT SEND CASH.
- R. Mail ORDER FORM(S) and PRE-PAYMENT to the EROS DATA CENTER. IF PAYMENT HAS BEEN PREVIOUSLY FORWARDED TO ANOTHER FACILITY, PLEASE FORWARD THIS ORDER TO THAT FACILITY FOR PROCESSING.

★ U.S. G.P.O. 1978-768-776/28 REG.#6

TYPICAL USERS AND APPLICATIONS

FEDERAL AGENCIES	
● BUREAU OF LAND MANAGEMENT	GEOHYDROLOGICAL ANALYSIS - DENALI REGION, ALASKA
● SOIL CONSERVATION SERVICE/SD	GRASSLAND TO CROPLAND CONVERSION MONITORING
● CORPS OF ENGINEERS	ENVIRONMENTAL INFORMATION SYSTEMS
● ENVIRONMENTAL PROTECTION AGENCY	STRIP MINING MONITORING
● DEPARTMENT OF AGRICULTURE	LACIE
INDUSTRY	
● PAPER PRODUCTS CORPORATIONS	FOREST RESOURCE STUDY
● DATA ANALYSIS CONSULTANTS	LAND COVER MAPPING
● LARGE CONSTRUCTION CONTRACTORS	SITE SELECTION & CONSTRUCTION PLANNING
● OIL CORPORATIONS	EXPLORATION & ACQUISITIONS FOR PETROLEUM RESOURCES
● NATURAL RESOURCES CONSULTANTS	THIRD WORLD NATURAL RESOURCE INVENTORIES
● MINERAL EXPLORATION CORPORATIONS	URANIUM EXPLORATION
NON-U.S.	
● MEXICO	LAND USE MAPPING
● BOLIVIA	MINERAL EXPLORATION
● FAO	PEST CONTROL
● INDIA	WATER RESOURCES STUDY
(120 NATIONS)	
ACADEMIC	
● HARVARD	TERRAIN ANALYSIS
● UNIVERSITY OF CALIFORNIA-BERKELEY	RENEWABLE RESOURCE INVENTORY STUDY
● UNIVERSITY OF ALASKA	EARTHQUAKE HAZARD STUDIES
● UNIVERSITY OF MICHIGAN	VEGETATION ANALYSIS
● S.D. SCHOOL OF MINES AND TECHNOLOGY	MINING EXPLORATION STUDIES
STATE & LOCAL GOV'T	
● STATE OF OREGON/WRD	INVENTORY OF IRRIGATED LANDS- KLAMATH RIVER BASIN
● PACIFIC NORTHWEST REGIONAL COMMISSION	LAND RESOURCES INVENTORY
● SOUTH DAKOTA STATE PLANNING BUREAU	LAND USE MAPPING
● APPALACHIAN REGIONAL COMMISSION	LINEAMENT ANALYSIS

Figure 27

TOTAL SHIPPED REIMBURSABLE SALES*

JULY, 1972 THROUGH APRIL, 1979

LANDSAT IMAGERY	1,052,422 FRAMES	\$6,506,674 (50%)
OTHER SATELLITE IMAGERY	65,004 FRAMES	376,571 (3%)
AIRCRAFT IMAGERY	<u>1,064,687 FRAMES</u>	<u>4,133,687 (32%)</u>
TOTAL	2,182,113 FRAMES	\$11,016,932
CCT'S	10,491 SCENES	1,929,982 (15%)
GRAND TOTAL SALES	2,192,604 ITEMS	\$12,946,914

*EXCLUDES MISCELLANEOUS DATA AND DBT'S.

Figure 28

5/14/79

LANDSAT IMAGERY DATA DEMAND

	FY 73	FY 74	FY 75	FY 76	TQ 76	FY 77	FY 78	Oct 78-Mar 79
FRAMES	81,071	157,178	197,654	246,449	50,804	130,100	110,723	66,211
DOLLARS	\$228,042	\$528,514	\$764,889	\$1,237,862	\$274,229	\$1,082,428	\$1,441,368	\$820,040

39

LANDSAT CCT DATA DEMAND

	FY 73	FY 74	FY 75	FY 76	TQ 76	FY 77	FY 78	Oct 78-Mar 79
ITEMS	10	228	729	2,289	1,010	1,887	2,853	1,303
DOLLARS	\$1,600	\$36,480	\$144,120	\$403,531	\$178,042	\$371,409	\$534,700	\$226,800

Figure 29

LANDSAT IMAGERY SHIPPED REIMBURSABLE DOLLARS BY USER CATEGORY

(INCLUDES NASA INVESTIGATORS)

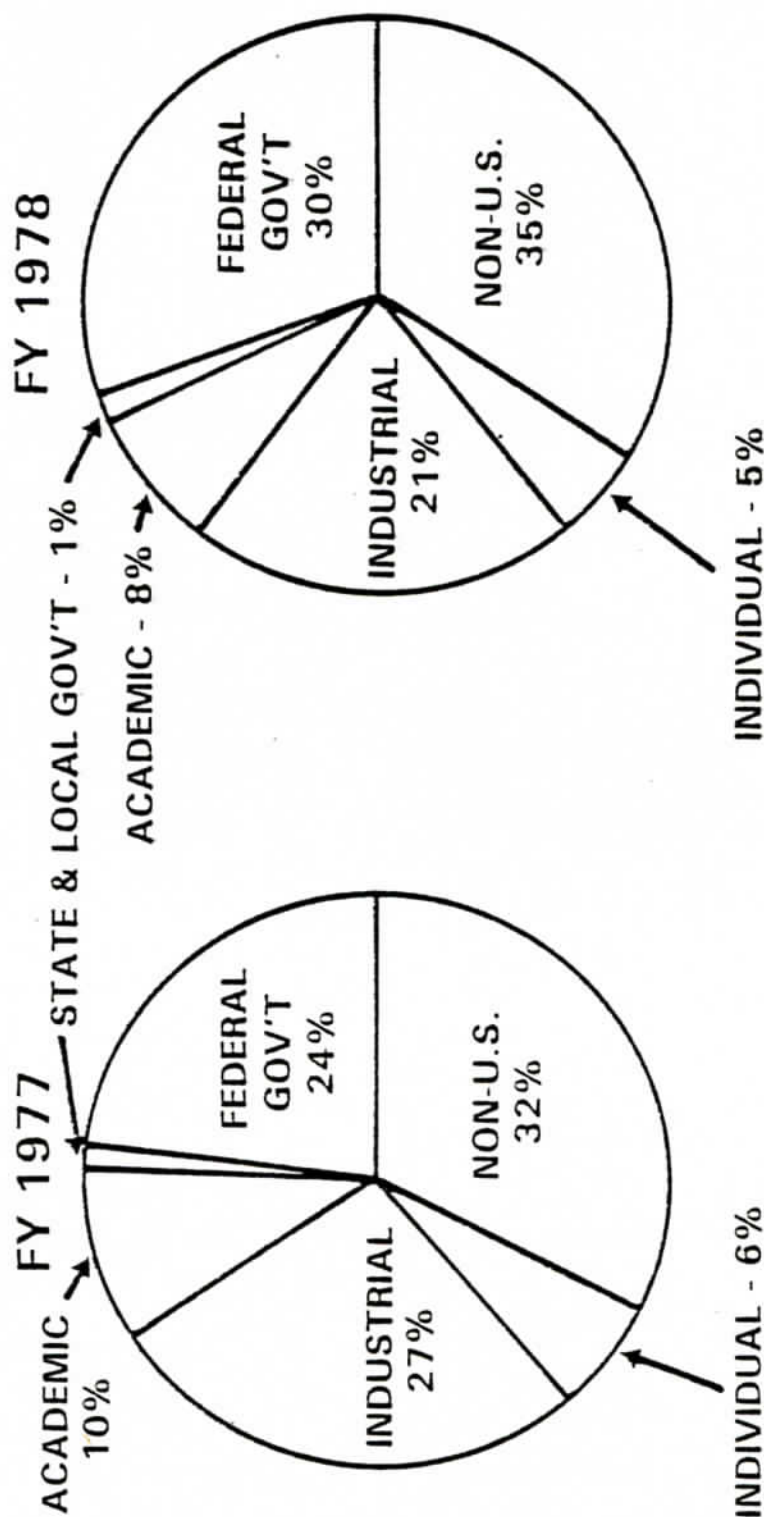


Figure 30

5/14/79

LANDSAT CCT'S SHIPPED REIMBURSABLE DOLLARS BY USER CATEGORY

(INCLUDES NASA INVESTIGATORS)

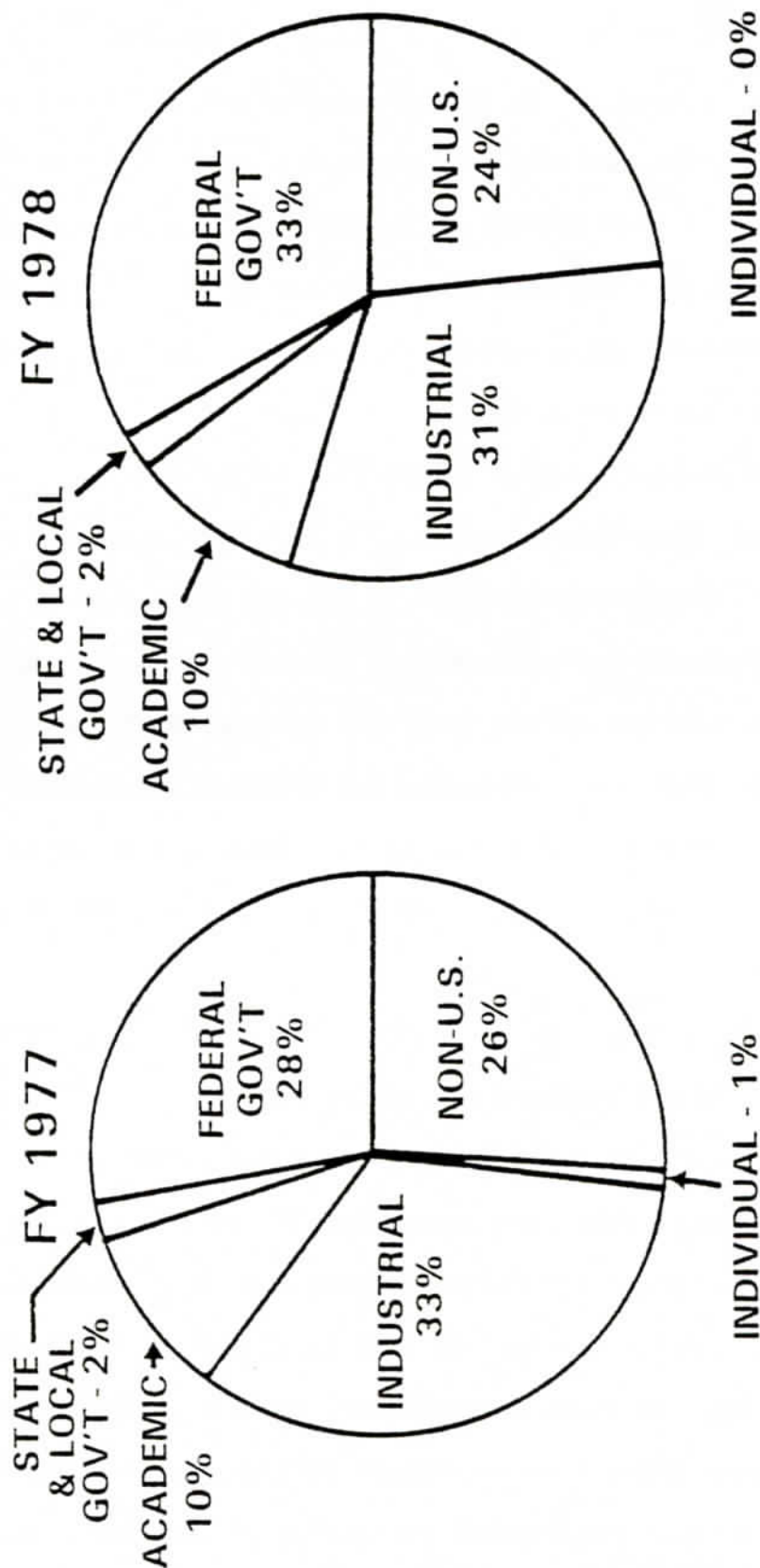


Figure 31

5/14/79

and that are the easiest to interpret by the widest range of users. Early in February 1979, in conjunction with the startup of NASA's new processing facility, EDC implemented the EROS Digital Image Processing System (EDIPS) to handle Landsat 2 MSS and Landsat 3 MSS and RBV imagery acquired after January, 1979. In addition to the improvement of image information content, reduction in data turnaround times has been realized.

The standard output of EDIPS is a geometrically and radiometrically corrected, digitally enhanced, 9 1/2-inch film negative which can be used as a master reproducible in the EDC photographic reproduction operations. The corrections are performed at Goddard and include adjustments to detector gain and offset (MSS) and shading (RBV), correction for Earth rotation (MSS), and correction for platform instability (both MSS and RBV). In addition, the data is conformed to the Hotine Oblique Mercator map projection using cubic convolution as the standard resampling technique.

These corrections are already done to the data when it is transmitted to EDC. During standard processing by EDIPS, the data is enhanced by applying a contrast stretch algorithm and formatted for film output. In addition to producing master images for this standard enhancement, EDIPS also offers the customer their choice of atmospheric scatter correction (haze removal) or edge enhancement. The parameters of these enhancements may also be specified; and the enhancements may be compounded on the same scene (i.e., contrast stretch can be combined with haze removal or edge enhancement processing if desired). Any of these options are available on the CCT. It is also possible, through EDC, to request

Goddard to provide digital data without the standard geometric corrections (CCT's only) or resampling. These are known as retrospective orders to Goddard, and the customer may specify cubic convolution or nearest neighbor resampling to either the Hotine or the Universal Transverse Mercator/Polar Stereographic Map Projections. Once received, EDC can apply the various EDIPS options to these retrospective orders. Figure 32 summarizes the options and products available.

Since beginning operation in February the IPF/EDIPS system has processed an average of 140 MSS scenes per day. Due to delays in implementation of parts of the IPF, twin panchromatic RBV data acquired after January 31 are not yet being processed. The flow of this data is expected to begin shortly.

In an ongoing effort to improve service to the user community, the next set of improvements to the Landsat system is under development. The EDIPS capability at EDC will be upgraded to handle uncorrected data. This upgrade is expected to be operational by late 1980, and will involve switching from a corrected data archive at EDC to an uncorrected data archive. This will offer the customer the advantage that: (1) the flexibility of the products available would increase, and (2) processing time would generally decrease. Retrospective ordering of digital data from GSFC for alternate map projections, resampling, or geometrically uncorrected data would no longer be necessary. With "raw" data archived at EDC, the customer will be able to request any valid combination of processing options and receive this data in a minimum amount of time. This upgrading of present system capabilities and resulting improvement of service to the user community will apply to both MSS and RBV data.

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Worldwide Landsat data is available upon user demand from EDC or through the various NCIC offices throughout the U. S. and from the foreign countries that have Landsat data reception capabilities. The geographically cataloged data is easily accessible and available to all users for the charge of reproduction. Ground processing equipment is being improved to provide the data with increased information content in a timely fashion to the user communities.

AVAILABILITY OF LANDSAT DATA PRODUCTS

Slide Presentation Given By R. A. Pohl, USGS/EROS Data Center, at the
Fifth Annual William T. Pecora Symposium
Satellite Hydrology
June 11, 1979

<u>PAO Slide Number</u>	<u>Slide Title</u>
E-6444-35	Availability of Landsat Data
E-8504-35	Approximate Receiving Ranges of Worldwide Landsat Ground Stations
E-6458-35	Available Landsat Products, Canada
E-6460-35	Available Landsat Products, Brazil
E-6462-35	Available Landsat Products, Italy
E-8443-35	EDC Building with Antenna
E-3512-35	EDC - Film Archive
E-8498-35	CCT Archive
E-8500-35	HDT Archive
E-8506-35	EDC Film Holding
E-5036-35	Landsat Film Products
E-5037-35	Landsat Paper Products
E-8507-35	Digital Products
E-4967-35	Determining Landsat Imagery Availability at EDC
E-8508-35	Geographic Retrieval Methods
E-8520-35	WRS Map of Africa
E-3069-35	Geographic Search Options
E-5153-35	User Services
E-5155-35	Terminal Operation
E-3584-35	Burroughs 6700
E-8509-35	Computer Listing Information Content
E-4976-35	Geographic Computer Search Inquiry Form
E-6739-35	Micrographic Accession Aids System
E-6741-35	Micrographic Accession Aids System
E-6743-35	Landsat Accession Aids Zone Map
E-6748-35	Landsat Accession Aids -- Zones and Regions
E-8516-35	MicroCATALOG
E-8495-35	MicroCATALOG Microframe Blowup
E-8515-35	MicroIMAGE

<u>PAO Slide Number</u>	<u>Slide Title</u>
E-8519-35	Microfiche Reader
E-8502-35	Browse Room
E-8497-35	EDC Information Network
E-6957-35	Inquiry Slide
E-6958-35	Contact Slide
E-6956-35	Orders
E-6959-35	Frames Produced
E-6960-35	CCT's Produced
E-7885-35	Archive/Data Demand Relationship
E-7887-35	Typical Users and Applications
E-8362-35	EDC Sale of Landsat Imagery Frames
E-8360-35	EDC Sale of Landsat CCT Scenes
E-8359-35	Data Demand Trends
E-8364-35	Landsat Data Distribution Sources
E-8365-35	Landsat Customer Profiles FY 78
E-8517-35	Landsat 1 and 2 Data Flow
E-8512-35	Domsat
E-8518-35	Landsat 3 Data Flow
E-8521-35	Domsat Antenna
E-7463-35	EDIPS
E-8587-35	EDIPS System Configuration (Block Diagram)
E-6467-35	EDIPS Pipeline Processing
E-8588-35	EDIPS Special Order Processing (Input)
E-8589-35	EDIPS Special Order Processing (Enhancement)
E-8522-35	EDIPS Special Order Processing (Output)